

MH88D0762

# **NATIVE AMERICAN RESEARCH AND TRAINING CENTER**

---

Monograph Series

---

DIABETES AND THE AMERICAN INDIAN:  
A REVIEW OF CURRENT TREATMENT STRATEGIES

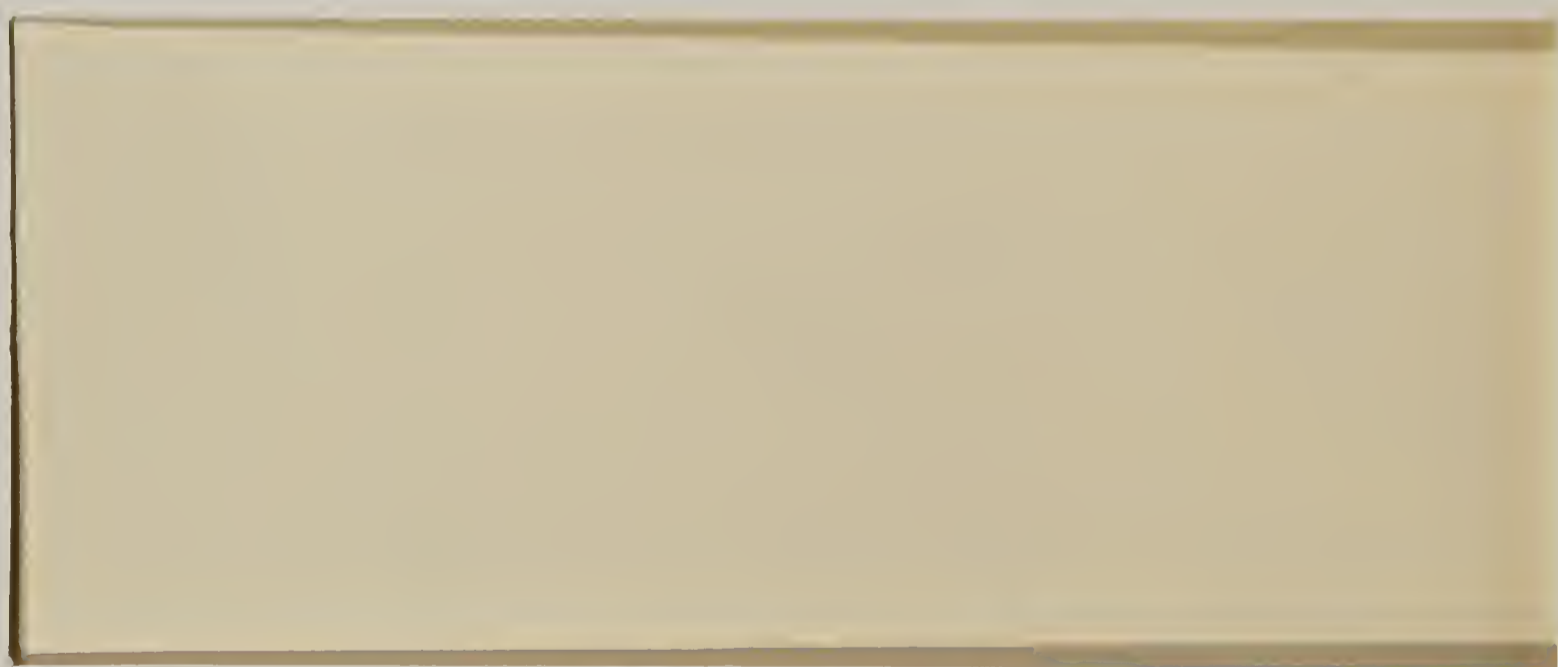
by

Robert S. Young, Ph.D.



**THE UNIVERSITY OF ARIZONA  
TUCSON, ARIZONA**

MH88D0762



DIABETES AND THE AMERICAN INDIAN:  
A REVIEW OF CURRENT TREATMENT STRATEGIES

by

Robert S. Young, Ph.D.



## ERRATA PAGE

Page 1 Second paragraph, fourth sentence, change incidence to prevalence.

Page 2 Section I.) change INCIDENCE to PREVALENCE.

Page 2 First paragraph, first sentence, change incidence to prevalence.

Page 2 First paragraph, last sentence, change 1984 to 1985.

Page 2 Second paragraph, second sentence, change incidence to prevalence.

Page 2 Second paragraph, eight sentence, change incidence to prevalence.

Page 2 Second paragraph, thirteen sentence, change incidence to prevalence.

Page 3 First paragraph, second sentence, change incidence to prevalence.



## INTRODUCTION

One of the most critical health problems facing Native Americans (American Indians, Alaskan Natives) today is the increasing incidence of Type II, non-insulin dependent diabetes mellitus (NIDDM). A heterogeneous group of diseases, NIDDM is usually defined as a chronic, progressive, incurable ailment characterized by (1) insulin resistance (receptor or post-receptor) that results in poor glucose utilization (2) hyperglycemia, and (3) hyperinsulinemia (Marble, 1985). Few patients suffering from NIDDM actually die from the disease; mortality in these patients is generally attributable to secondary complications resulting from prolonged hyperglycemia.

The following review surveys the current relevant literature about NIDDM, with particular emphasis on the impact of the disease on the Native American population. The review is divided into three major areas: (1) incidence, mortality, and morbidity; (2) etiology and treatment; and (3) summary and recommendations. The final section includes suggestions for innovative research projects that may be of relevance to the Native American community.



## I.) INCIDENCE, MORBIDITY, MORTALITY

### I.A.) Incidence

The incidence of Type II diabetes is on the increase among Native Americans. The Indian Health Service reports that the total number of outpatient visits at IHS facilities for diabetic related illnesses increased by 15.5% from FY 1981 to FY 1984 (IHS, 1985). Among the Pimas, the number of new cases of diabetes increased by 1/3 in the period 1975-84 compared to the comparable ten year period 1965-74 (Sievers and Fisher, 1984).

Diabetes is currently the second leading cause of outpatient visits to IHS facilities (IHS, 1985). The incidence of NIDDM among Native Americans varies intertribally: approximately 50% of the adult population of the Pimas in southern Arizona over age 35 suffer from the disease (Sievers and Fisher, 1984), and health officials estimate that between 50% and 70% of all adult Tohono O'Odham over age 35 will develop the disease (Hoffman and Haskell, 1984). An incidence of 20% or greater for adults over age 35 has been reported for the Upland Yumans (37.6%), Cocopah (34.2%), Maricopa (29.8%), San Carlos Apache (24.9%), Zuni (31.5%), Paiute (25.9%), Seminole (37.8%), Cherokee (29.0%), Pawnee (24.6%), Seneca (30.9%), and Cheyenne-Arapahoe (19.5%) (Sievers and Fisher, 1985). An incidence of NIDDM greater than 10% in adults has been recorded for the Cauhilla and Lulseno of California, the Washoe, White River Apache, Navajo, Choctaw, Chickasaw, Kickapoo, Sauk and Fox, Shawnee, Kiowa and Comanche, Alabama-Coushatta, and Passamaquoddy



(Sievers and Fisher, 1984). These figures compare with an overall incidence (diagnosed) of NIDDM in the United States of 2.35% for all age groups (Sievers and Fisher, 1984).

#### **I.B.) Morbidity and Mortality**

Morbidity and mortality associated with NIDDM is associated primarily with secondary illnesses and complications such as vascular problems, which include (1) diabetic retinopathy, leading to impaired vision, cataracts, glaucoma, and blindness; (2) diabetic nephropathy, which leads to end-stage renal disease (ESRD); and (3) increased frequency of cardiovascular associated diseases including coronary artery disease and lower limb vascular disease that results in of gangrene and lower limb amputation. Additional complications from NIDDM include (1) increased susceptibility to infection; (2) increased rates of periodontal disease; (3) increased rates of perinatal mortality and congenital abnormalities, and (4) neuropathy (Rhoades, 1986; Bennett, 1986).

Statistics compiled by the National Institute of Health (NIH) about NIDDM patients throughout the country reveal that approximately 20% have developed kidney disease 15 years after diagnosis of diabetes, 45% develop cardiovascular related diseases (Coronary heart disease, ischemic heart disease) 20 years after diagnosis, and 50% suffer from hypertension. Strokes occur two to six times as frequently in diabetics as in non-diabetics; peripheral vascular disease is present in 45% of



patients after 20 years; 40-45% of all non-traumatic amputations are diabetes related, and length of survival after amputation for 50% of the patients is less than three years. Approximately 22% report visual impairment, 12% report cataracts, 11% report glaucoma (2-3 times the rates for the general population), and 5% report severe visual impairment (Sievers and Fisher, 1984).

Morbidity rates are even higher for American Indians. Approximately 50% of the Indian End Stage Renal Disease (ESRD) patients have diabetes, and the renal failure rate for Indians is 3.5 times the rate for Caucasians (Hoffman and Haskell, 1984; Rhoades, 1986). According to Rhoades (1986), 46.8% of Pima Indians suffering from diabetes for ten years or more had some form of retinopathy, and 29% suffering from ischemic heart disease also had diabetes listed as a discharge diagnosis.

## II.) ETIOLOGY and TREATMENT

Epidemiological evidence from population and family studies suggest a genetic predisposition for NIDDM. Although genetics may be a factor, environmental factors such as diet and lifestyle as described below appear to play a critical role in the manifestation of the disease in susceptible individuals.

### II.A.) Heredity

The evidence for a genetic basis for NIDDM comes from population and family studies. The almost 100% concordance of NIDDM in twins (assuming control for variables such as diet,



exercise, etc.) suggests a definite genetic basis as does the high incidence of NIDDM in specific populations (Kaplan and Atkins, 1985; Marble et al., 1985), including Native Americans and Mexican Americans with a gene pool drawn from Native American roots. In a study of a Hispanic population in three neighborhoods in San Antonio, Texas, incidence of diabetes was found to correspond proportionately to the Native American gene mixture (Gardner et al., 1984).<sup>\*</sup> Prevalences of 14.5%, 10%, and 5% corresponded respectively to a Native American gene admixture of 46%, 27%, and 18% (Gardner et al., 1984). A study of three affiliated Indian tribes at Ft. Berthold, North Dakota, by Brosseau et al. (1979) correlating diabetes with percentage of Indian inheritance found that full inheritance Indians age 35 or older had a prevalence rate of 22.3%, those with an inheritance rate of 50%->100% had a prevalence rate of 22.3%, and those with less than 50% Indian inheritance had a prevalence rate of 4.1%, which was comparable to the rate of diabetes among the white population residing on the reservation.

A genetic predisposition for NIDDM was first suggested by Neel (1962), who postulated the existence of a "thrifty gene." According to Neel's theory, early peoples existed through feast-famine cycles, and the so-called "thrifty gene" would have had a selective advantage because it increases the ability of the body

---

<sup>\*</sup>The technique for determining Native American gene admixture was based upon skin reflectance on a non-sun exposed site (Korey, 1980; Relethford et al., 1981; 1983).



to store fats (energy) that could later be metabolized during periods of food shortage. The "thrifty gene" becomes a detrimental trait, however, given a plentiful food supply, resulting in obesity and ultimately, diabetes (Neel, 1962). Because of the hyperinsulinemia that characterizes some cases of NIDDM, Neel (1982) has recently hypothesized that the mechanism of the thrifty gene involves an over-responsive beta cell and down regulation of insulin receptor response levels. In a recent study of Pima Indians, Knowler et al. (1983) suggest that the "thrifty gene" may enhance the ability of insulin to maintain fat stores in spite of resistance to glucose utilization.

A second theory based on a genetic etiology for NIDDM was proposed by Gabbay (1980). Point mutations in the B-chain of the insulin molecule at the binding sites may lead to an insulin:receptor-site binding that results in a diminished ability of receptors to bind additional insulin (Gabbay, 1980).

A number of investigators have attempted to define a specific locus for a gene that correlates with manifestation of NIDDM in selected patients. The authors of one recent study have observed that development of Type II diabetes is associated with the presence of HLA antigen A2a (Williams et al., 1981). Other studies have indicated that the specific chromosomal site may be a DNA polymorphism inserted on the short arm of chromosome 11, located in the 5' flanking region of the insulin gene (Owerbach and Nerup, 1982; Rotwein et al. 1982). This site differs from the chromosomal site suggested as a possible genetic basis for Type I, Insulin Dependent Diabetes Mellitus (IDDM) in non-Indians (Ginsberg-Fellner, 1981; see also Marble et al., 1985, pp. 21-27



for a detailed discussion of this problem).

## II.B.) Obesity

### 1.) Epidemiology

Approximately 60-90% of all patients suffering from NIDDM are obese and partial reversibility of symptoms at early onset is correlated with weight loss and caloric restriction for these patients (Pirat et. al., 1978). Causes of this obesity may be attributed to the sedentary lifestyle (see below) of the subjects combined with ingestion of foods high in fats and simple carbohydrates.

That Indians were not obese in previous centuries is evidenced from photographs and records (for a review, see West, 1978). Public Health records indicate that diabetes among Indians during the early decades of the twentieth century was extremely rare (West, 1978). Data listing heights and weights of Tohono O'Odham men collected in 1938 by Dr. Norman Gable has been recovered and compared with data collected for the period 1978-1985 (Justice, 1985). Broken down by age groups, the data revealed the following average weight difference between subjects from 1938 and 1985 for selected age groups: ages 18-24, 57 lbs.; ages 25-34, 50 lbs.; ages 35-45, 50 lbs. (Justice, 1985). The average weight of the 18 to 24 year old Tohono O'Odham men in 1938 was 156 lbs. (compared to 148 lbs. for the non-Indians); today, the average weight of 18 to 24 year old Tohono O'Odham men is 213 lbs. (Justice, 1985).



In a study of Dogrib Indians in the Northwest Canadian Territories, Szathmary and Holt (1983) found that hyperglycemia was associated specifically with upper trunkal deposition of body fat. Diabetes was unknown among these Indians before 1979; highest incidence appears to be among those Indians living in a village linked by roads all year-round to metro population centers. The Indians living in this particular village no longer hunt, trap, or fish on a regular basis (Szathmary and Holt, 1983). The authors note that skin-fold indices indicate that these Indians are not more obese (emphasis mine) than comparable Euro-American population groups or their normoglycemic kinsmen; the only difference between these Indians and their Euro-American peers is that their body fat tends to be "centripetally located" on the upper trunk as opposed to being deposited proportionately all over, and the authors suggest that this type of fat deposit may somehow be correlated with a predisposition to NIDDM, (Szathmary and Holt, 1983).

A recent study among Pima Indians by Pettit et al. (1983) has introduced another variable into the relationship between obesity and diabetes. The authors have reported that children born to mothers suffering either from gestational diabetes or NIDDM tend to have significantly heavier birth weights than children born to the same mothers before onset of diabetic symptoms (Pettit et al., 1983). At ages 15-19, 58% of the subjects weighed 140% or more of their desirable weight compared to 17% from non-diabetic mothers (Pettitt et al., 1983). Justice (1985) maintains that this data casts doubt on Neel's "thrifty



gene hypothesis" as the primary basis for the increase in diabetes in this population. Pettitt et al. (1984) have found that incidence of NIDDM is 6-10 times higher in children of diabetic mothers and is independent of obesity. In recent testimony before Congress, Bennett (1986) noted that 40% of children born to diabetic mothers have diabetes by the ages 15-19 regardless of obesity, compared with 3% of children of mothers who were not diabetic during pregnancy.

Only a few studies have attempted to analyze the diet in various Indian communities because of the difficulties of such studies and the obvious problem of individual variation. Hesse (1959) reported that the diet for Pimas is high in unsaturated fats (24% of total diet) with Lard comprising 15% of the caloric intake. Average total caloric intake was 2781 Kcal/day, which is only slightly above normal (Hesse, 1959). Mayberry and Lindemann (1963) reported high consumption of pork fats and lard, and low consumption of milk and milk products for Seminoles in Oklahoma. Caloric intake for the Seminoles was 2484 Kcal/day compared to an intake of 1861 Kcal. for a comparable non-Indian population in Oklahoma (Mayberry and Lindemann, 1963). The authors attributed the differences in caloric intake to the relative youthfulness of the Indian population that was studied (Mayberry and Lindemann, 1963). West (1978) reports in preliminary observations that diets for the Five Tribes and the Plains Indians of Oklahoma contain approximately 50% fats.

In a study of the Mohave Indians reported in 1966, the authors determined that 75% of the diet consisted of fried carbohydrate (Mohs et al., 1985). Drevets (1977) reports that the



diet for Choctaw Indians is in excess of 4000 Kcal. Judkins (1978) quotes a source that reports an average dietary intake of 4,359.9 Kcal./day for Seneca males, which is approximately 50% above the recommended caloric intake for active normal adults. These studies demonstrate that diets for the population groups studied are (1) extremely high in fats, and (2) are in general excessively high in caloric intake. The question these studies raise is whether over nutrition contributes directly to the onset of diabetes or indirectly to the disease process through weight gain.

The connection between over nutrition and hyperglycemia (reduced insulin mediated storage of glucose) has been studied by Henry et al. (1986) and Mott et al. (1986). In a remarkable study of the effect of overnutrition on plasma insulin levels, Mott et al. (1986) have shown that short term overnutrition in obese, non-diabetic Indian males induced a reduction in insulin mediated glucose storage rates, which are associated with increased fasting plasma insulin levels. In an effort to elucidate the mechanisms involved, the authors demonstrated a reduction in muscle glycogen synthase activity (Mott et al., 1986). Significantly, these results suggest a strong association between total caloric intake and development of NIDDM.

## 2.) Diet Therapy

Pirat et al. (1978) have observed that 60-90% of all NIDDM patients are obese, and indeed obesity is a a predictor for



NIDDM. The exact biochemical mechanism by which obesity leads to NIDDM is unknown, although recent work by Mott et al. (1986) suggests a relationship between over-nutrition and onset of symptoms. Of significance is the data which demonstrates that the effects of NIDDM, which include insulin resistance and reduced tissue permeability to insulin, are reversed by weight reduction (Doar et al., 1975, Wing, 1985; Henry et al., 1986). Thus investigators have concluded that dietary restrictions should have a beneficial effect for these patients. The question, however, is what is the most appropriate diet for these patients. The diets currently recommended by the American, British, and Canadian Diabetes Associations include the following: fat content, 30%, preferably unsaturated and low in cholesterol; complex carbohydrates, 45%-60%; and protein, 12%-20% (Arky et al., 1982). Effectiveness of this diet therapy is related to duration of disease and appears to be more effective for patients in the earlier stages of disease (West, 1980).

Weight loss through caloric restriction and dietary regulation lowers blood glucose levels. Doar et al. (1975) and Savage et al. (1979) demonstrated that weight loss and dietary restrictions produce significant improvements in glucose tolerance and control. Wales (1982) has demonstrated that energy restricted diets (reduced caloric intake) are more effective for weight loss than carbohydrate restricted diets. Of 182 patients in the three month study reported by Wales, 37 brought their blood glucose levels under control, but 29 individuals remained poorly controlled (Wales, 1982). Those patients who lost weight showed significantly greater improvement in glucose tolerance,



but reported no change in insulin response (Wales, 1982). In an interesting study by Henry et al. (1986), eight obese subjects with NIDDM were placed on strict diets that resulted in an average weight loss per subject of  $16.8 \pm 2.7$  Kg.

The authors found that in correlation with this weight loss plasma glucose levels decreased from an average of  $277 \pm 21$  to  $123 \pm 8$  mg./dl., adipocyte size was reduced by 44%, and glycosylated hemoglobins were reduced from an average of  $11.9 \pm 0.8\%$  to  $7.5 \pm 0.4\%$ . The authors concluded that reduced basal hepatic glucose output and an increase in insulin sensitivity were responsible for lowering fasting glucose levels.

The one long term study evaluating the effectiveness of diet therapy has been recently reported by Kaplan et al. (1985), who found a reduction of  $0.43\%$  ( $-0.43\%$ ) in glycosylated hemoglobin compared to an increase of  $0.36\%$  ( $+0.36\%$ ) in the glycosylated hemoglobin in the control group after 18 months. Although the subjects experienced some weight loss at the beginning of the study, total weight loss at the end of the experiment was negligible.

Dietary restrictions under the most ideal of circumstances are frequently difficult to comply with for all affected populations (West, 1980). Ideally the patient will (1) reduce caloric intake, and (2) eat several small meals daily in order to prevent carbohydrate loading; thus meals may have to be prepared at odd times. Diet therapies are designed individually for each patient, depending on the patient's needs, i.e., a lean patient is not put on a diet to lose weight. Furthermore, diabetic



patients are always hungry (polyphagia) because the body's cells are starved for energy. As a result, the diabetic subject tends to overeat.

Meals prescribed for the Native American diabetic may be different from those consumed by the rest of the family and may require special preparation, thus creating problems within the family structure. These problems are further compounded for Native Americans because of the cultural implications of eating and drinking. In many tribes, the offer of food in a familial or in a social context carries with it social and cultural implications. Rejection of the food may be accompanied by guilt as well as possible social stigma; on the other hand, acceptance of the food may also be accompanied by guilt if the patient understands the need for weight reduction and the dietary restrictions prescribed by the physician (Joe, 1986). The situation is a classic double-bind, and the patient generally resolves the dilemma by making the most culturally appropriate choice: succumbing to socio-cultural expectations.

## II.C. "Sedentary Lifestyle:"

### 1.) Definition of "Sedentary Lifestyle"

Because diabetes was virtually nonexistent among Native Americans prior to 1940, a number of investigators have searched for specific environmental factors that may account for the increasing incidence of this disease. Both diet and a sedentary life style have been implicated as major factors in the onset of



the NIDDM (Justice, 1986). Among Alaskan Athabascan Indians and Eskimos who lead active outdoor lives, diabetes has been rare until recently, with moderate increases in obesity and incidence of diabetes corresponding to changes to a more sedentary lifestyle (Mouratoff and Scott, 1973).

The phrase "sedentary lifestyle" is difficult to define and impossible to quantify. The following specific example presented by Justice (1985) is an attempt to explain this phrase by providing a contrast between the present and past lifestyles of the the Tohono O'Odham.

The Tohono O'Odham in Southern Arizona, whose incidence of diabetes is currently 42% for adults age 35 or older, led a semi-nomadic existence prior to European incursion. In general, these people resided in the mountains during the winter months and on the deserts during the summer. During the summer, families tilled four to five fields in expectation that plants would survive in only two of the fields because of the harsh desert climate. Food sources consisted largely of plants from among the 400 or so edible species that grow in the Sonora desert, especially Mesquite beans, which are high in carbohydrate and protein (Justice, 1985). In general, food was scarce, difficult to obtain, and the acquisition of this resource represented the primary activity of the people.

Since the turn of the century, the lifestyle of the Tohono O'Odham has changed radically. The people are no longer semi-nomadic. Livestock raising and improved agricultural practices have eliminated the need for manpower resources, and the high



unemployment, a constant supply of food resources (including processed foods), and an increase in caloric intake combined with a relatively sedentary existence due to mechanization and motor vehicle transportation has led to a more sedentary lifestyle (Justice, 1985). The consequences of the change in lifestyle in this population group are an increase in obesity and diabetes.

## 2.) Therapy: Exercise

### a.) Exercise and Blood Glucose

During exercise, muscle consumption of blood borne glucose increases 7-40 times basal level, depending on intensity and duration of activity (Felig and Wahren, 1979). Glucose is the primary source of energy during short periods of high intensity exercise and during moderate exercise for up to 30 minutes. In moderate exercise of longer duration, free fatty acids generated by adipocyte lipolysis replaces glucose as the primary source of energy.

During periods of short, high intensity exercise activity, the initial source of glucose is muscle glycogenolysis, which results in a transient net glucose release from the exercising muscle (Skyler, 1979). As exercise is prolonged, hepatic glycogenolysis becomes the primary source of glucose. Factors stimulating hepatic glycogenolysis include 1.) a drop in insulin levels, 2.) an increase in glucagon levels, 3.) increase in growth hormone levels, and 4.) elevation in plasma catecholamines and cortisol (Skyler, 1979). A small net uptake of



glucose in muscle begins and lactate is released, indicating anaerobic glycolysis. With continued exercise, lactate release subsides and glucose uptake in the muscles continues to increase. After 15 minutes, the major source of blood glucose appears to be hepatic gluconeogenesis (Felig and Wahren, 1979).

Production of glucose is in part mediated by the production and release of a number of regulatory hormones, including catecholamines, glucagon, growth hormone, cortisol, and insulin. Release of these hormones is mediated by (1) duration of exercise activity, (2) intensity of the exercise, and (3) physical fitness of the subject. Exercise of short duration (5 to 8 min.) results in a consistent decrease in insulin, probably as a result of stimulation of the adrenergic system, i.e., epinephrine 1.) stimulates muscle glycogenolysis, hepatic gluconeogenesis, and glucagon secretion, and 2.) inhibits insulin secretion (Skyler, 1979; Vranic and Berger, 1979). Growth hormone release is maximized during moderate exercise. Release of cortisol, glucagon, and the catecholamines (resulting in an increase of glucose) is associated with intensity and duration of exercise activity (Vranic and Berger, 1979).

During exercise for the normal subject, glucose utilization is balanced by glucose production. Strenuous exercise results in a 15-20% increase in plasma glucose because of hepatic glucose production. Progressive, mild exercise for several hours results in a fall in plasma glucose (Skyler, 1979). Exercise also results in a suppression of insulin secretion, although insulin availability may be increased due to increased blood flow,



vasodilation, etc. (Vranic and Berger, 1979). Studies have shown that insulin and norepinephrine responses are decreased with training (Vranic and Berger, 1979). This effect may be analogous to downloading, i.e., greater amounts of hormone (more intense exercise) are required in order to elicit a response from the cells.

#### b.) Exercise and Diabetes

Presuming that a sedentary lifestyle that includes a lack of physical activity is indeed a contributing factor to obesity and therefore NIDDM, investigators have for many years attempted to promote exercise as a therapeutic response that helps facilitate weight reduction and lower high blood glucose levels. Exercise would appear to be an appropriate therapy for the maturity-onset diabetic because it increases glucose utilization and decreases insulin requirements. (Vranic and Berger, 1979). Pederson et al. (1980) suggest that exercise increases the affinity of insulin for its receptors, thus explaining the lowering of blood glucose levels in the NIDDM subject. Results of a study evaluating the effectiveness a six month exercise program for six patients using a bicycle ergometer (eight to ten 3 minutes bout of exercise interspersed with 3 minute rest periods) produced modest improvement in glucose tolerance and possible enhancement of insulin activity (increased insulin activity), but glucose tolerance deteriorated and glucose and insulin levels increased within two weeks of cessation of training (Ruderman et al., 1979). Thus the authors conclude that the key to using exercise



as an effective intervention strategy is that exercise must become a permanent part of the patients lifestyle (emphasis mine) (Ruderman et al., 1979).

Another study involving twenty subjects who used a bicycle ergometer three times per week for six weeks resulted in significant decreases in glycosylated hemoglobin levels in the subjects (Schneider et. al., 1979). The authors attributed the reduction to the cumulative effect of transient improvements in glucose tolerance following each period of exercise (Schneider et al., 1979). The implications of this study are that lower levels of glycosylated hemoglobin would delay or lessen the probability of serious secondary complications associated with NIDDM.

Significant studies of the value of exercise using Indian subjects suffering from NIDDM have shown similar results. One study conducted at the Phoenix Indian Hospital involved six obese Southwest American Indians who for 6-10 weeks trained on a bicycle ergometer 5-6 days weekly for periods ranging from 20-40 minutes. Results of fasting plasma glucose (all six subjects) and oral glucose tolerance (five out of six) showed significant lowering of plasma glucose levels (Reitman et al., 1984).

Perhaps the most significant study involving the application of exercise therapy for Indians suffering from NIDDM has been the ongoing exercise program conducted at Zuni Pueblo in New Mexico. Prevalence of diabetes among this group is estimated at approximately 40% for the over 45 age group. From July 1983 to September 1985, 220 individuals, ages 22-55 (including 35 diabetic subjects) participated in a structured program that



included aerobic classes, running, and weight control programs. A system of bonus rewards for losing weight or for achieving specific short term goals in aerobic fitness were used in order to encourage participation (Leonard et al., 1986). Significant weight loss was reported, and most of the diabetic subjects showed lowered fasting serum glucoses (Leonard et al., 1986).

As with diet therapies, the most important question concerns the long term effectiveness of such an intervention strategy. Long term studies on the effectiveness of exercise and/or diet therapies for NIDDM patients have been lacking until recently. Kaplan et al. (1985) recently completed an 18 month study in which they evaluated diet, exercise, and a combination of diet and exercise. The exercise regimen consisted of stretching exercises and walking. After 18 months, the diet and exercise group showed the greatest reductions in glycosylated hemoglobin (-1.48% compared to + 0.36% for the controls) even though weight loss in this group was negligible. There were no significant differences between the diet and the diet plus exercise groups for LDL cholesterol, total cholesterol, and triglycerides (Kaplan et al., 1985). A similar study by Wing et al. (1985) in which patients were put on a 16 week program of diet and exercise and then evaluated at a 16 month follow up showed that both (emphasis mine) modest weight loss and exercise resulted in significant improvements in blood sugar control.

The results of these studies (Kaplan et al., 1985; Wing et al., 1985) demonstrate that the benefits of exercise may depend on intensity and duration of the exercise period as well as combining the exercise program with restricted caloric intake. Of



particular interest in Kaplan's study are the results of the glycosylated Hemoglobin studies of the exercise only group. After eighteen months, this group showed an elevated (emphasis mine) glycosylated hemoglobin (+1.30% compared to the control group with +0.36%) (Kaplan et al., 1985), implying that exercise of long duration or high intensity may have been hazardous for these patients.

As an intervention strategy, exercise must become a permanent part of the patient's lifestyle in order to be beneficial. Duration of the disease is also a factor, i.e., exercise is more effective for those diabetics with relatively low glucose levels or who have a recent onset of symptomology. But there are problems with this intervention strategy, particularly for elderly American Indians. Many diabetic patients are middle aged or older, and exercise is difficult to implement for this population group because of lifestyle and possible health risks. It is difficult to imagine elderly Indians participating actively in an aerobics program because such participation might not be considered culturally appropriate behavior.

#### II.D.) Stress

For purposes of this review, stress will be discussed in two contexts as defined by Young (1980) and Mikhail (1980): (1) biochemically and physiologically, i.e., to describe situations that are threatening or otherwise noxious to the subject, resulting in certain neuroendocrinological and physiological responses that may, if prolonged, have physically debilitating



and maladaptive consequences; and (2) psychologically and psychosocially, i.e., as a measure of a subjects emotional response to the external world in terms of "locus of control." This second category, which Young (1980) calls "psychogenic stress," evaluates stress within a patient's psychosocial context.

The phrase "locus of control" requires clarification. An individual with a strong "internal locus of control" accepts responsibility for what happens and believes himself capable of influencing or affecting the outcome of events in which he is involved (Rotter, 1966; Trimble, 1983). A person with an "external locus of control" attributes responsibility for events in his life to powerful external forces such as fate, which are beyond that person's control.

#### 1.) Stress and Diabetes: the Biochemical Basis:

The autonomic nervous system has a direct neural as well as an indirect hormonal effect on glucose metabolism. Beta adrenergic stimulation facilitates hepatic glycogenolysis as well as the formation of free fatty acids. Epinephrine and cortisol, which are secreted in response to stress, elevate glucose levels and adversely affect glucose absorption. The pancreas contains alpha and beta adrenergic receptors. Thus stimulation of the right vagus nerve and of beta adrenergic receptors facilitates insulin secretion; stimulation of the alpha adrenergic receptors inhibits secretion of insulin (Williams and Porte, 1974). Thus the autonomic nervous system, which is



activated by a stressful situation in the environment, plays a direct role in the regulation of both carbohydrate and lipid metabolism.

Measurements correlating psychological stress and emotional states with diabetic symptomatology have been attempted by a number of investigators (Hinkle, and Wolf, 1952a; 1952b; Cox et al., 1984). Psychological stress has been directly correlated with the onset of diabetic illness episodes in several studies with type I diabetes (IDDM) (Treuting, 1962; Hinkle and Wolfe, 1950; Hinkle and Wolfe, 1952a; 1952b;). Other studies have also demonstrated that psychological stress and emotional liability are implicated in episodes of increased hyperglycemia and ketoacidosis in patients with Type I diabetes (Peck and Peck, 1956; Stearns, 1959; Cohen et al., 1960; Baker et al., 1975). Bradley (1979) has demonstrated that stressful life events are associated with disturbances of diabetic control in patients with Type I diabetes, but less so with patients that have type II diabetes.

That stress would affect blood glucose levels in Type I diabetes is logical. That stress does effect blood glucose levels in Type II diabetes has been clearly demonstrated in animal experiments. In a series of experiments with obese and lean mice (C5BL/6 ob/ob) susceptible to type II diabetes, Surwit et al. (1985) demonstrated that hyperglycemia can be induced in these animals only if they are subjected to environmental stressors. The authors successfully induced hyperglycemia in both lean and obese mice through classical conditioning



techniques (Surwit et al., 1985). In a follow-up study, Surwit et al. (1986) demonstrated that benzodiazepine alprazolam (a tranquilizer) administered intraperitoneally to obese and lean mice of the same species modified the hyperglycemic effect of stress in these animals by reducing corticosterone levels (in the obese mice) and raising insulin levels (in both the lean and obese mice). The authors concluded that tranquilizers such as the benzodiazepines may have clinical significance for type II diabetics subject to acute stressful life events.

## 2.) Therapy for Stress

If stress is a significant factor in the onset of diabetic symptoms, then it is reasonable to assume that stress release activities would be beneficial to diabetic patients. Stress release activities such as relaxation therapy and biofeedback have been shown to be effective in reducing and/or helping to control hypertension (Stone and Deleo, 1976; Benson et al., 1971; Kleinman and Goldman, 1974), control of cardiac arrhythmias (Weiss and Engel, 1971; Miller, 1975), in modifying EEG rhythms and improvement of epileptic conditions (Sterman, 1973), in reducing frequency of chronic headaches (Budzynski et al., 1973; Sargent et al., 1973), and in the rehabilitation of injured muscles (Marinacci, 1973; Jacobs and Felton, 1969; Brundy et al., 1974). Jevning et al. (1978) demonstrated that meditation exercises reduced plasma cortisol levels, and Davidson et al., (1979) have shown that cardiac patients trained in deep muscle relaxation therapy have a decrease in plasma norepinephrine and



indices of myocardial contractility. Thus as Surwit et al. (1983) have noted, behavioral regulation of autonomic nervous system activity should also have a medically beneficial effect for both types of diabetes.

Cognitive and behavioral strategies using biofeedback, progressive muscle relaxation, and intensive family psychotherapy have been implemented in the treatment of diabetics. As early as 1939, Daniels discussed clinical trials conducted by Bauch in 1936 in which daily muscle relaxation exercises and hypnotic suggestion resulted in a significant reduction in the insulin requirements in Type I diabetic patients. Several other investigators have reported reduced insulin requirements for type I diabetics following relaxation training (Fowler et al., 1976; Seburg and DeBoer, 1980).

In a study with NIDDM patients, Surwit et al. (1983) used EMG-feedback assisted relaxation training in a hospital setting that allowed for control of diet and physical activity. After nine days, the experimental group showed significantly lower blood glucose levels following administration of the oral glucose tolerance test; patients in the control group, on the other hand, had significant increases in blood glucose levels. One of the implications of this study is the possibility that some diabetics can be taught to utilize the relaxation techniques they have learned to restabilize blood glucose levels when they are out of control. Unfortunately, attempts at applying the same procedure to Type I diabetics were unsuccessful, raising interesting questions about the mechanism by which biofeedback proved effective for NIDDM patients (Surwit et al., 1986).



These studies may be relevant to some Native Americans because meditation, or a form thereof has been used for centuries by American Indians. Called "spirit travelling" or "spirit walking" (Locust, 1986), the technique appears to be similar to eastern forms of meditation that employ visualization. Unfortunately, scholarly studies about the use of this technique by Native American peoples are lacking.

### 3.) Psychogenic Stress and the Native American

Cross-cultural and acculturational stresses for the Native American community have been studied extensively by those concerned with problem drinking within urban and reservation communities (Mail, 1980; Thomas, 1981; May, 1977; May 1982; Schaefer, 1981). Much of this cross-cultural conflict stems from differences in the relationship of the individual to society. For most Native Americans, the group is the normative base of culture (Leland, 1976). This emphasis on group identification by Native Americans contrasts with the dynamics and values of Western culture, in which individuality and competition are encouraged as the means to gain recognition and success. These differences between the two cultures have resulted in a conflict in values for many Native Americans. Mail (1981) and Jones-Saumty et al. (1983) have analyzed this conflict in values and traditions between Native Americans and Euro-American cultures, and have concluded that the lack of tolerance for differences by the WASP (Mail, 1980) makes it virtually impossible for the Native American to be bicultural in Western society. A number of



authors have defined the consequences for Indians of these cross cultural and acculturation stresses as anomie, cultural disruption, social disintegration, poor self-image, poverty, a sense of powerless, and exploitation by the dominant culture (May, 1977; Jilek, 1981; Royce, 1981).

In a study of the Dogrib Indians of Canada, Szathmary and Holt (1983) attempted to relate cross cultural stresses to the incidence of Diabetes. The authors concur with Vague et al. (1979) that "android" obesity may be produced by overactivity of the pituitary-adrenal axis, resulting from "minor hypercorticism acting over a period of many years" (Vague et al., 1979). Szathmary and Holt (1983) suggest that the psychological stress of acculturation may influence glucocorticoid secretion in these people. However, the authors fail to distinguish between two different kinds of stressors: (1) cross cultural stresses, which lead to a change in diet and an increase in caloric consumption, and (2) the stress on the body which is caused by obesity. Nevertheless, these preliminary studies (Vague et al., 1979; Szathmary and Holt, 1983) provide an interesting connection between stress, obesity, and diabetes that needs to be explored further.

#### 4.) Health Beliefs of the Native American

To understand the nature of the cross cultural stress experienced by Native Americans and to determine cause and effect relationships between these stresses and diabetes is extraordinarily difficult. Essential to such a study would be an



assessment of the health beliefs of the people being studied. Such assessments may also be useful in predicting compliance behavior. A number of authors writing about health beliefs systems have noted that compliance behavior by the patient who suffers from a chronic illness depends on (1) the value of the outcome of the therapy to the individual and (2) the individual's estimate that compliance will have an effect on outcome (Mikhail, 1981; Rosenstock, 1960; Becker and Maiman, 1975). In effect, the therapy enables the patient to restore a "sense of control" (internal locus of control) or "order" in their lives.

Unfortunately few studies have assessed Native American perceptions of diabetes. In a recent study of the Tohono O'Odham, Hoffmann and Haskell (1984) found that the Native Americans classified diseases such as diabetes, cancer, and most infections as "White Man's diseases," which therefore required treatment by IHS physicians. However, the inability of the IHS physician to pinpoint a precise etiology of a disease such as diabetes and the lack of awareness of cultural problems associated with Western therapies has only exacerbated the problem of compliance among these patients. When the western physician informs the Native American patient that he or she has diabetes, the physician also tells them that the disease is chronic, incurable, and progressive. From the perspective of the health belief system of some Indians, this is a sentence of death. The patient feels not only that the disease is beyond his/her control, but also that all efforts to follow a strict medical regimen to control this disease are useless.



Dispensing medical information in the manner characteristic of Western medical practice is foreign to traditional Native American approaches to illness, which seeks to "heal" the patient by helping him/her to restore balance, or harmony, between themselves and the rest of the world even though the illness may be chronic and debilitating (Locust, 1986). In effect, the patient learns how to live with the disease. In the Western biomedical model, which is based on a mind-body dualism, this approach to "healing" would be classified as psychological and therefore perceived to be of dubious value in the treatment of illness that is the result of a metabolic imbalance or deficiency. Non-Native Americans who have emotional problems as a result of a chronic illness are referred to a psychiatrist for evaluation.

The Native American diabetic who leaves the physician's office and who may not yet be feeling secondary complications from his disease, often feels that compliance serves no useful function because (1) they may be asymptomatic, and thus reject the diagnosis, (2) they are told that the disease is incurable, or (3) the disease does not fit into his/her sociocultural perception of an illness. Deprived of the belief that he/she can do something effective that will help maintain health, the patient may simply give up. Many Indians may pursue alternative approaches to health care, i.e., consult with indigenous healers. For some Indians who have strong beliefs in the immortality of the spirit, the body is no longer useful and can be discarded, i.e., the medical regimen is ignored and the patient awaits death.



Compliance with the treatment protocols requires appropriate knowledge and understanding of the disease by the patient and the belief that with appropriate intervention, the disease can be managed and controlled. Unfortunately, such knowledge appears to be difficult to acquire despite workshops and outpatient counseling programs. In a study among the Zunis, for example, eighteen (86%) of twenty-two patients questioned felt that diabetes was a disease that traditional healers would know nothing about and should therefore be treated by "anglo" doctors (Camazine, 1980). However, when questioned by the author (Camazine, 1980) about the causes of diabetes, seven did not know anything about the disease or how it was "contracted," eleven (50%) stated that the disease was a problem with sugar or with their diet, and four (18%) believed that it was hereditary.

A vast body of educational information about diabetes is available to patients; however, this information is often not translated into explanations that are easily comprehended. Although we all speak and read English, the connotations of much of the language are culturally dependent. It would be interesting, for example, to have asked those respondents at Zuni who attributed their diabetes to hereditary factors to define precisely what "hereditary" means to them. For many Native Americans, heredity and heritage are virtually synonymous, and thus such a response from these patients could have profound social implications not intended by a physician or the author of the educational materials.

This problem with language is not unique to Native



Americans. The average middle class person with a college education will also probably interpret the word "heredity" to mean that all efforts at stabilizing the disease are ultimately doomed to failure, i.e., the disease is beyond their control. Essential to educational programs about diabetes for both Indians and non-Indians is that although the disease may be familial, proper measures will prevent onset of the disease for those not yet afflicted and enable those who do suffer from diabetes to stabilize and control their blood sugar levels.

#### III.D.) Summary and Recommendations

Researchers currently attribute the high incidence of NIDDM in the American Indian population to a combination of genetic and environmental factors. Because of the correlation between obesity and NIDDM, physicians advocate a weight reduction treatment program jointly with an exercise regimen as the most appropriate therapy for stabilizing and/or lowering blood glucose levels in order to control/prevent the onset of secondary complications. Exercise alone has been shown to have limited utility in lowering blood glucose levels; weight loss through caloric restricted diets appears to be more effective, although weight loss appears to be a difficult process for many diabetics. Indeed, some researchers speculate that diabetics may have a unique metabolic situation that makes it especially difficult to lose weight (Mott, 1986; Surwit, 1986).

Studies with obese mice and with Type II diabetics have demonstrated that stress is a factor in maintaining glycemic



control and may be implicated in the etiology of the disease. Relaxation techniques using biofeedback have been shown to be effective in helping patients both to lower and to stabilize blood glucose levels.

As a result of this study, this author has attempted to define a number of areas for further research in the treatment of NIDDM:

1.) Educational programs: A critical need exists for educational programs that are designed with particular sensitivity to language differences among populations. Although we all speak English and use the same words, these same words frequently have different connotations which are largely derived from our cultural backgrounds. Thus educational programs must be designed that not only discuss the etiology and treatment of the disease within appropriate cultural contexts, but also emphasize for these patients how the disease can be successfully controlled within these same cultural contexts.

Programs must also be designed that provide sensitivity training to IHS personnel about the cross-cultural stress that results from the differences between Native American cultural values and Western biomedical attitudes. Too often the IHS medical worker assumes that the language and terminology from the western biomedical model is universally understood and is the only appropriate way to communicate with the patient.

One of the most interesting approaches to educating Indians suffering from diabetes has been developed at the University of Toronto for the Native Diabetes Program, which serves urban



Ojibway and Cree Indians (Hagey, 1984; Hagey and Buller, 1983). This educational material is not presented as factual information, but is presented within a metaphorical context derived from Ojibway mythology that is tied to deeper meaning structures. The story presented is based on two mythological figures, Nanabush, the symbol of moderation, a wise, capable individual who, like all human beings, frequently makes mistakes and seems to be fumbling his way through life; and Windigo, who represents excess and easily succumbs to peer pressure and external forces, therefore symbolizing a lack of morality and spirituality (Hagey, 1984).

The author adds that the thrust of this teaching is that each individual has a choice: Nanabush represents "Internal control," of being in balance and harmony, of having spiritual strength and responsibility; Windigo represents an "external, overpowering force" which causes one to be out of balance with nature and with family, to be vulnerable, to blame others, resulting in a breakdown of family unit. Thus both alcoholism and diabetes are envisioned as due to a lack of spiritual strength, i.e., succumbing to the temptations of Windigo (Hagey, 1984).

A similar approach was used in Florida in a four day workshop to educate tribal representatives from the Seminole Nation on the need to adopt a healthier lifestyle (Moody and Laurent, 1984). The authors presented the educational materials in a series of five folk tales based on Seminole mythology. Each tale addressed a specific health problem relevant to diabetes and described the appropriate behavior for dealing with the problem.



The authors point out that there are two major advantages to using folk tales as an educational medium for peoples for whom folk tales are an integral part of their culture: (1) they transcend language barriers, and (2) they enable people to perceive cause and effect relationships between health behavior and favorable results.

2.) Support Groups: Use of support groups (e.g., talking circles) or a family advocate model for Native Americans suffering from NIDDM would be particularly helpful for those individuals experiencing stress related problems (Joe, 1986). The burden of a chronic, progressive disease, the demands made upon the family unit (e.g., preparation of food, etc.), and the possible "taint" of having a white man's disease tend to isolate stricken individuals, resulting in emotional problems that may exacerbate the disease process.

3.) Use of alternative, indigenous, holistic therapies to help patients control their disease: Such therapies include relaxation and meditation techniques. These alternative therapies do not "cure" the disease, but may be used as adjunct therapies that help the patient reestablish a sense of control over his/her health.

4.) Instruction in food preparation: For selected groups of Native Americans, over 25% of the caloric intake is derived from lard, and 50% of the diet by weight is fat (primarily unsaturated fat). The problems of obesity, particularly in children, might be controlled in part by the implementation of instructional



techniques in food preparation that eliminate the high fat content characteristic of the diet of many Native Americans.

5.) Cross-cultural assessment of the health beliefs of the Native Americans who suffer from this disease: such assessment would not only be instructive for medical and other interested personnel, but would also allow for the design and implementation of intervention strategies within a culturally appropriate context for the treatment of this disease.



## REFERENCES

- Arky, R. Wylie-Rosett, J., El-Beheri, B. (1982). Examination of current dietary recommendations for individuals with diabetes mellitus. Diabetes Care. 5:59-63.
- Baker, L., Minuchin, S., Milman, L. et al., (1975). Beta adrenergic blockade and juvenile diabetes mellitus: a progress report. Mod. Probs. in Ped. 12:332-43.
- Becker, M.H. and Maiman, L.A., (1975). Sociobehavioral determinants of compliance with health and medical care recommendations. Med. Care. 13:10-24.
- Bennett, Peter H. (1986). "Statement before the select committee on Indian Affairs, United States Senate: April 15, 1986."
- Benson, H., Shapiro, D., Tursky, B. and Schwartz, G. (1971). Decreased systolic blood pressure through operant conditioning techniques in patients with essential hypertension. Science. 173:740-42.
- Bradley, Clare. (1979). Life events and the control of diabetes mellitus. J. Psychosomatic Res. 23:159-62.
- Brosseau, J.D., Eelkema, R.C., Crawford, A.C., and Abe, T.A. (1979). Diabetes among the three affiliated tribes: correlation with degree of Indian inheritance. Am J. of Public Health. 69:1277-8.
- Brundy, J., Grynbaum, B.B., and Korein, J. (1974). Spasmodic toticollis: treatment by feedback display of the EMG. Archives of Phys. Med. and Rehab. 55:537-47.
- Budzynski, T.H., Stoyva, J.M., Adler, C.S., and Adler, C. (1973). Feedback-induced muscle relaxation: application to tension headache: J. of Behavior Ther. and Exp. Psychiatry. 1:205-211.
- Camazine, S.M. (1980). Traditional and western health care among the Zuni Indians of New Mexico. Soc. Sci. Med. (Med. Anthropol.). 14B:73-80.
- Clayton W. (1984). Prevalence of diabetes in Mexican Americans. Relationship to percent of gene pool derived from Native American sources. Diabetes. 33:86-92.
- Cohen, A.S. Vance, V.K., and Runyan, J.W. (1960). Diabetic Acidosis: an evaluation of the cause, course, and therapy of 73 cases. Ann Int. Med. 73:55---.



Cox, Daniel J., Taylor, Ann Gill, Nowacek, George, Holley-Willcox, Pamela, Pohl, Stephen L. (1984). The relationship between psychological stress and insulin-dependent diabetic blood glucose control: preliminary investigations. Health Psychology 3:63-75.

Daniels, G.E. (1939). Present trends in the evaluation of psychic factors in diabetes mellitus. A critical review of the experimental, general medical, and psychiatric literature of the last five years. Psychosomatic Medicine. 1:527-552.

Davidson, Dennis M., Winchester, Mark A., Taylor, C. Barr, Alderman, Edwin A. and Ingels, Neil. (1979). Effects of relaxation therapy on cardiac performance and sympathetic activity in patients with organic heart disease. in: Biofeedback and Behavioral Medicine, ed. D. Shapiro, J. Stoyva, J. Kamiya, T.X. Barber, N.E. Miller, and G.E. Schwartz. New York: Aldine Publishing Co.

Doar, J.W.H., Wilde, C.E., Thompson, M.E., Sewell, P.F.J. (1975). Influence of treatment of diet alone on oral glucose-tolerance test and plasma sugar and insulin levels in patients with maturity-onset diabetes. Lancet. (June 7), pp. 1263-66.

Drevets, C.C. (1977). Diabetes Mellitus in Choctaw Indians. Diabetes Forecast. 58:322-29.

Feinglos, Mark N., Hastedt, Priscilla, and Surwit, Richard D. (1986). The effects of relaxation therapy on patients with type 1 diabetes mellitus. (In press).

Felig, Philip, and Wahren, Hohn. (1979). Role of insulin and glucagon in regulation of hepatic glucose production during exercise. Diabetes. 28(1):71-75.

Fowler, J.E. Budzynski, T.H., and Vandenberg, R.L. (1976). Effects of an EMG biofeedback relaxation program on control of diabetes. Biofeedback Self Regulation. 1:105-112.

Gabbay, Kenneth H. (1980). The insulinopathies. New England Journal of Medicine. 302:165-167.

Gardner, Lytt I., Stern, Michael P., Haffner, Steven M., Gaskill, Sharon P., Hazuda, Helen P., Relethford, Hohn H., and Eifler, Clayton W. (1984). Relationship to percent of gene pool derived from Native American sources. Diabetes: 33:86-92.

Ginsberg-Fellner, F. (1981). In the genes. Diabetes Forecast. 34:31-33.

Hagey, R., and Buller, E. (1983). Drumming and dancing: a new rhythm in nursing care. Can. Nurse. 79(4):28-31.



- Hagey, Rebecca. (1984). The phenomenon, the explanations and the responses: metaphors surrounding diabetes in urban Canadian Indians. Soc. Sci. Med. 18:265-72.
- Henry, R.R., Wallace, P., and Olefsky, J.M. (1986). Effects of weight loss on mechanisms of hyperglycemia in obese non-insulin-dependent diabetes mellitus. 35:990-998.
- Hesse, Frank G. (1959). A dietary study of the Pima Indian. Am. J. of Clin. Nutrition. 7:532-37.
- Hinkle, Lawrence E., and Wolf, Stewart. (1950). Experimental study of life situations, emotions, and the occurrence of acidosis in a juvenile diabetic. American Journal of Medical Science. 217:130-35.
- Hinkle, L.E., and Wolf, S. (1952a). The effects of stressful life situations on the concentration of blood glucose in diabetic and nondiabetic humans. Diabetes. 1:383-92.
- Hinkle, L.E. and Wolf, S. (1952b). Importance of life stress in the course and management of diabetes mellitus. Journal of the American Medical Association, 148:258-63.
- Hoffman, B.H., and Haskell, A.J. (1984). The Papago Indians: historical, social, and medical perspectives. Mt. Sinai J. Med. 6:707-13.
- Indian Health Service: A Comprehensive Health Care Program for American Indians and Alaska Natives. (1985). Rockville, Md.: U.S. Dept. of Health and Human Services.
- Jacobs, A. and Felton, G.S. (1969). Visual feedback of myoelectric output to facilitate muscle relaxation in normal persons and patients with neck injuries. Arch. of Phys. Med. and Rehab. 50:34-39.
- Jevning, R., Wilson, A.F., and Davidson, J.M. (1978). Adrenocortical activity during meditation. Hormones and Behavior. 10:54-60.
- Jilek, Wolfgang G. (1981). Acculturation, alcoholism and Indian style alcoholics anonymous. J. Stud. Alc. suppl. 9:159-70.
- Joe, Jennie. (1986). Personal communication. Dr. Jennie Joe is Director of the Native American Research and Training Center, Tucson, Arizona.
- Jones-Saumty, Deborah, Hochhaus, Larry, Dru, Ralph, and Zeiner, Arthur. (1983). Psychological factors of familial alcoholism in American Indians and Caucasians. J. of Clin. Psych. 39:783-90.
- Judkins, R.A. (1978). American Indian medicine and contemporary health problems. IV. Diabetes and perception of diabetes among Seneca Indians. NY State J. Med. 78: 1320-3.



Justice, James, M.D. (1985). Type II diabetes mellitus in the Tohono O'odham. Lecture given at O.R.D. in Tucson, Arizona, December 12, 1985.

Kaplan, R.M. and Atkins C.J. (1985). The behavioral management of type II diabetes mellitus, in Behavioral Epidemiology and Disease Prevention, ed. by R.M. Kaplan and M.H. Criqui. New York: Plenum Press, pp. 353-383.

Kaplan, Robert M., Hartwell, Sherry L., Wilson, Dawn K., and Wallace, Janet P. (1985).

Kleinman, K.M., and Goldman, H. (1974). Effects of biofeedback on the physiological and cognitive consequences of essential hypertension. Proc. of the Biofeedback Res. Soc. (Abstract). p.37.

Knowler, W.C. Pettitt, D.J., Bennett, P.H., and Williams, R.C. (1983). Diabetes Mellitus in the Pima Indians: genetic and evolutionary considerations. Am. J. Phys. Anthropol. 62:107-14.

Korey, K.A. (1980). Skin colorimetry and admixture measurements: some further considerations. Am. J. Phys. Anthropol. 53:123-28.

Leland, Joy. (1976). Firewater Myths: North American Indian Drinking and Alcohol Addiction. New Brunswick: Rutgers U. Center of Alcohol Studies. Monograph #1.

Leonard, Bruce, Leonard, Carole, and Wilson, Robert. (1986). Zuni diabetes project. Public Health Reports. 101:282-88.

Locust, Carol. (1985). Indian Concepts of Health and Unwellness. Monograph. Tucson:Native American Reserch and Training Center.

Locust, Carol. (1986). Personal communication. Dr. Locust is a Research Associate at the Native American Research and Training Center, Tucson, Arizona.

Mail, P. D. (1980). American Indian drinking behavior: some possible causes and solutions. J. Alc. Drug Ed. 26:28-39.

Marble, Alexander, Krall, Leo P., Bradley, Robert F., Christlieb, A. Richard, and Soeldner, J. Stuart. (1985). Joslin's Diabetes Mellitus (12th ed.). Philadelphia: Lea & Febiger.

Marinacci, A.A. (1973). The basic principles underlying neuromuscular re-education. in Biofeedback and Self-Control 1972: an Aldine Annual on the regulation of Bodily Processes and Consciousness, ed. D. Shapiro, T.X. Barber, L.V. DiCara, J. H. Kamiya, N.E. Miller, and J. Soyva. Chicago: Aldine, 1973.

May, P.A. (1977). Explanations of Native American drinking: a literature review. Plains Anthropologist. 22:223-32.



May, P.A. (1982). Substance abuse and American Indians: prevalence and susceptibility. Int. J. Addictions. 17:1185-1209.

Mayberry, Ruben H., and Lindemann, Robert D. (1963). A survey of chronic disease and diet in Seminole Indians in Oklahoma. Am. J. of Clin. Nutrit. 13:127-34.

Mikhail, Anis. (1981). Stress: a psychophysiological conception. Journal of Human Stress. (June). pp. 9-15.

Mikhail, Blanche. (1981). The health belief model: a review and critical evaluation of the model, research, and practice. Advances in Nursing Science. 20:65-80.

Miller, N.E. (1975). Applications of learning and biofeedback to psychiatry and medicine. In: Comprehensive Textbook of Psychiatry--II. ed. A.M. Freedman, H.I. Kaplan, and B.J. Saddock. Baltimore: Williams and Wilkins.

Mohs, Mary E. Leonard, Tina K., and Watson, Ronald R. (1985). Selected risk factors of diabetes in Native Americans. Nutrition Research. 5:1035-45.

Moody, Linda E., and Laurent, Mary. (1984). Promoting health through the use of storytelling. Health Education. January/February, pp. 8-12.

Mott, D.M., Lillioja, S. and Bogardus, C. (1986). Overnutrition induced decrease in insulin action for glucose storage: in vivo and in vitro in man. Metabolism. 35:160-65.

Mott, D.M., Clark, Randil, Andrews, W. John, and Foley, James. (1986) Insulin-resistant Na<sup>+</sup> pump activity in adipocytes from obese humans. Am. J. Physiol. 249 (Endocrinol. Metab 12): E160-E164.

Mouratoff, George J., and Scott, Edward M. (1973). Diabetes in Eskimos after a Decade. JAMA, 226:11.

Neel, J.V. (1962). Diabetes mellitus: a "thrifty" genotype rendered detrimental by "progress"? Am. J. Hum. Genet. 14:353-362.

Neel, J.V. (1982). The thrifty genotype revisited. In The Genetics of Diabetes Mellitus, ed. J. Kobberling and R. Tattersall. New York: Academic Press, pp. 283-93.

Owerbach, D., and Nerup, J. (1982) Restriction fragment length polymorphism of the insulin gene in diabetes mellitus. Diabetes. 31:275-77.

Peck, F.B., and Peck, F.B. Jr. (1956). Tautologous diabetic coma: A behavior syndrome: Multiple unnecessary episodes of diabetic coma. Diabetes. 5:44----



Pederson, O., Beck-Neilsen, H., Heding, L. (1980). Increased insulin receptors after exercise in patients with insulin dependent diabetes mellitus. New England J. of Medicine. 302:886-892.

Pettitt, David J., Baird, H. Robert. Kirk, A. Aleck., Bennett, Peter H., and Knowler, William C. (1983). Excessive obesity in offspring of Pima Indian women with diabetes during pregnancy. New England J. of Med. 308:242-5.

Pettitt, D.J., Baird, H.R., Carraber, M. and Knowler, W.C. (1984). Genetic and intrauterine effects in transmission of diabetes mellitus. Abstract. Am. J. Epidemiol. 120:477.

Pirat, J. (1978). Diabetes mellitus and its degenerative complications: a prospective study of 4,400 patients observed between 1947 and 1973. Diabetes Care. 1:168-88.

Reitman, James S., Vasquez, Barbara, Klimes, Iwar, and Nagulesparan, Murugasu. (1984). Improvement of Glucose homeostasis after exercise training in non-insulin dependent diabetes. Diabetes Care. 7:434-41.

Relethford, J.H. and Lees, F.C. (1981). Admixture and skin color in the transplanted Tlaxcaltecan population of Saltillo, Mexico. Am. J. Phys. Anthropol. 56:259-67.

Relethford, J.H., Stern, M.P., Gaskill, S. P., and Hazuda, H.P. (1983). Social class, admixture, and skin color variation in Mexican Americans and Anglo Americans living in San Antonio, Texas. Am. J. Phys. Anthropol. 61:97-102.

Rhoades, Everett, M.D. (1986). Statement before select committee on Indian Affairs, United States Senate: April 15, 1986.

Rosenstock, I.M. (1960). What research in motivation suggests for public health. Am. J. Public Health. 50:295-302.

Rotter, J.B. (1966). Generalized expectancies for internal versus external control of reinforcement. Psychological Monographs. 80:1-28.

Rotwein, P., Chirgwin, J., Cordell, B., Goodiner, H.M., Knowler, W.C., and Permutt, M.A. (1982). Insulin gene polymorphism and diabetes. Diabetes 31:185a- .

Royce, J.E. (1981). Alcohol Problems and Alcoholism. New York: Free Press.

Ruderman, Neil B., Ganda, Om P., and Johansen, Klaus. (1979). The effect of physical training on glucose tolerance and plasma lipids in maturity-onset diabetes. Diabetes. 28: Suppl. 1, 89-92.



- Sargent, J.D. Walters, E.D., and Green, E.E. (1973). Psychosomatic self-regulation of migraine headache. Seminars in Psychiatry. 5:415-28.
- Savage, Peter, Bennian, Lynn J. Flock, Eunice V., Nagulesparan, M., Mott, David, Roth, Jesse, Unger, Roger, and Bennett, Peter H. (1979). Diet induced improvement of abnormalities in insulin and glucagon secretion and in insulin receptor binding in diabetes mellitus. J. Clin. Met. 48(6):999-1007.
- Schaefer, J.M. (1981). Firewater myths revisited: review of findings and some new directions. J. of Stud. on Alc. suppl. 9:99-117.
- Schneider, S.H., Amorosa, L.F., Khachadurian, A.K., and Ruderman, N.B. (1984). Studies on the mechanism of improved glucose control during regular exercise in Type 2 (non-insulin-dependent) diabetes. Diabetologia 26:355-60.
- Seburg, K.N., and DeBoer, K.F. (1980). Effects of EMG biofeedback on diabetes. Biofeedback and Self Regulation. 5:289-93.
- Sievers, Maurice L., and Fisher, Jeffrey R. (1985). Chapter XI. Diabetes in North American Indians. In: Diabetes in America. U.S. Dept. of Health and Human Services. NIH Publication no. 85-1468.
- Skyler, Jay S. (1979). Diabetes and exercise: clinical implications. Diabetes Care. 2:307-311.
- Slawson, P.F., Flyn, W.R., Kollar, E.J. (1963). Psychosocial factors associated with the onset and cause of diabetes mellitus. JAMA. 185:163-----.
- Stearns, S. (1959). Self destructive behavior in young patients with diabetes mellitus. Diabetes. 8:379-----.
- Sterman, M.B. (1973). Neurophysiologic and clinical studies of sensorimotor EEG biofeedback training: some effects on epilepsy. Seminars in Psychiatry. 5:507-25.
- Stone, Richard, and DeLeo, James. (1976). Psychotherapeutic control of hypertension. The New England Journal of Medicine. 294:80-84.
- Surwit, Richard S. and Feinglos, Mark N. (1983). The effects of relaxation on Glucose tolerance in non-insulin-dependent diabetes. Diabetes Care. 6:176-179.
- Surwit, Richard S., Feinglos, Mark N., and Scovern, Albert W. (1983). Diabetes and behavior. American Psychologist. 38:255-62.
- Surwit, Richard S., McCubbin, James A., Livingston, Elizabeth G., and Feinglos, Mark. (1985). Classically conditioned hyperglycemia in the obese mouse. Psychosomatic Medicine. 47:565-68.



- Surwit, Richard S. and Feinglos, Mark N. (1986). Stress, behavior, and glucose control in diabetes mellitus. (In press).
- Surwit, Richard S., McCubbin, James A., Kuhn, Cynthia, McGee, David, Gerstenfeld, David, and Feinglos, Mark N. (1986). Alprazolam reduces stress hyperglycemia in OB/OB mice. Psychosomatic Medicine.
- Szathmary, Eموke J.E., and Holt, Natasha. (1983). Hyperglycemia in Dogrib Indians of the Northwest Territories, Canada: Association with age and a centripetal distribution of body fat. Human Biol. 55:493-515.
- Thomas, Robert K. (1981). The history of North American Indian alcohol use as a community-based phenomenon. J.of Stud. Alcohol, suppl. 9:29-39.
- Treuting, T.F. (1962). The role of emotional factors in the etiology and course of diabetes mellitus. Amer. J. Med. Sci. 244:93- .
- Trimble, Joseph, and Richardson, Susan S. (1983). Perceived personal and societal forms of locus of control measures among Amercian Indians. White Cloud Journal. 3:3-14.
- University Group Diabetes Program: Effects of hypoglycemic agents on vascular complications in patients with adult-onset diabetes. VIII: Evaluation of insulin therapy: Final Report. (1982). Diabetes. (supplement 1) 31:1-113.
- Vague, J., Combes, M., Tramonì, M., Angeletti, Ph. Rubin, Hachem, A., Perey, D., Lansade, CH. Ziras, Ramahandridona G., Jouve, R., Sambuc, R., abd Jubelin, J. (1979). Clinical features of diabetogenic obesity. in J. Vague, Ph. Vague, and F.J.G. Eblin, (eds.), Diabetes and Obesity. Exerpta Medica. Amsterdam, pp. 127-47.
- Vranic, Mladen, and Berger, Michael. (1979). Exercise and diabetes mellitus. Diabetes. 28:147-163.
- Wales , J.K. (1982). Treatment of type 2 (non-insulin-dependent) diabetic patients with diet alone. Diabetologia. 23: 240-45.
- Weiss, T. and Engel, B.T. (1971). Operant conditioning of heart rate in patients with premature ventricular contractions. Psychosomatic Medicine. 33:301-21.
- West, Kelly. (1978). Diabetes in American Indians. Adv. Metab. Disord. 9:29-48.
- West, K.M. (1980). Recent trends in dietary management. In: Clinical Diabetes: Modern Management. ed. S. Podelsky. New York: Appleton-Century-Crofts, pp, 67-89.



Williams, R.C., Knowler, W.C., Butler, W.J., Pettitt, D.L., Lisse, J.R., Bennett, P.H., Mann, D.L., Johnson, A.H., and Terasdake, P.I. (1981). HLA-A2 and type II diabetes in Pima Indians: an association and decrease in allele frequency with age. Diabetologia.

Williams, R.H. and Porte, D., Jr. (1974). "The Pancreas": in Textbook of Endocrinology 5th ed. Philadelphia: Saunders.

Wing, Rena R., Epstein, Leonard H., Nowalk, Mary Patricia, Koeske, Randi, and Hagg, Sigrid. (1985). Behavior change, weight loss, and physiological improvements in type II diabetic patients. J. of Consulting and Clin. Psych. 53: 111-22.

Young, Alan. (1980). The discourse on Stress and the reproduction of conventional knowledge. Soc. Sci. & Med. 14B:133-146.

Zinman, Bernard, and Vranic, Mladen. The heterogeneous response to exercise in Diabetes Mellitus. (1982). The Mount Sinai J. of Medicine. 49:250-57.





